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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

Satoru HOSONO, et al.

Docket No: Q66059

Appln. No.: 09/942,764

Group Art Unit: 2853

Confirmation No.: 9203

Examiner: Blaise L. MOUTTET

Filed: August 31, 2001

For: INK JET RECORDING HEAD, METHOD OF MANUFACTURING THE SAME, METHOD OF DRIVING THE SAME, AND INK JET RECORDING APPARATUS INCORPORATING THE SAME

SUBMISSION OF APPEAL BRIEF

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith please find an Appeal Brief. A check for the statutory fee of $500.00 is attached. The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account. A duplicate copy of this paper is attached.

Respectfully submitted,

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WASHINGTON OFFICE
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Date: June 14, 2005

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APPEAL BRIEF UNDER 37 C.F.R. § 41.37

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an Appeal from the final rejection of November 16, 2004 of claims 1-14, 16, 17, 23-26, 30-32, 34, 35 and 37-44 in Application No. 09/942,764. In accordance with the provisions of 37 C.F.R. § 41.37, Appellant submits the following:

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I. REAL PARTY IN INTEREST

The real party in interest is SEIKO EPSON CORPORATION of Tokyo, Japan, the assignee of the present application. The assignment was recorded on December 6, 2001 at Reel 012349, Frame 0163.

II. RELATED APPEALS AND INTERFERENCES

Appellant, Appellant's legal representatives, and the assignee in this application are not aware of any other pending appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the instant appeal.

III. STATUS OF CLAIMS

Claims 1-44 are all the claims pending in the application. Claims 1-14, 16, 17, 23-26, 30-32, 34, 35 and 37-44 have been finally rejected and are the subject of this appeal. Claims 15, 18-22, 27-29, 33 and 36 stand objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form. All of the claims on appeal are set forth in the attached Appendix.

IV. STATUS OF AMENDMENTS

No claim amendments were requested subsequent to the Final Office Action of November 16, 2004.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

The present invention is directed to a method of manufacturing an ink jet recording head and an ink jet recording head manufactured by a particular method. The invention accounts for variations in ink ejection characteristics due to manufacturing tolerances, and enables suitable suppression of meniscus vibration in the recording head, even when the natural period of ink in the pressure chamber varies.

In particular, claim 1 is directed to a method whereby the ejection times are varied while pulses are being ejected, to measure the ink drop amount or speed. The recording heads are then classified into ranks based on these measurements.

Claim 1, the only independent claim, recites *inter alia*;

> executing a plurality of ink droplet ejections from the nozzle orifice, *while varying* an ejecting time duration as ejecting conditions to measure either corresponding ejected amounts of ink droplets or corresponding ejected speeds as ejecting results;
>
> identifying a correlation between the ejecting conditions and the ejecting results based on the plurality of ink droplet ejections; and
>
> classifying the assembled recording head into a plurality of ranks, based on the identified correlation.

Claim 1 (emphasis added).

With reference to Fig. 4, the application discloses a preferred embodiment whereby multiple "evaluation pulses" TP1 are ejected with varied generation times Pwh1.

> And, in the step of measuring the ink amount, a plurality of generation times Pwh1 are established. That is, a plurality of types of evaluation pulses TP1, in which the time Pwh1 of generation of the first holding element P2 differs, are used, and measurements of the amount of ink are carried out several times.
>
> In the present embodiment, the amount of ink is measured three times, by using a first evaluation pulse in which the time Pwh1 of generation is set to a first reference time that becomes the reference, a second evaluation pulse in which the time Pwh1 of generation is set to a second reference time that is shorter than the first reference time, and a third evaluation pulse in which the time Pwh1 of generation is set to a third reference time that is longer than the first reference time.

Application at 22:12-23.

The amount of ink ejected from these time-varied pulses is measured and the results are used to rank the recording head. Application at 23:15-26:22.

Certain dependent claims recite features pertaining to the natural period of pressure vibrations in the recording head. Factors that contribute to the natural period include the thickness and/or area of the resilient plate, shape of the pressure chamber, compressibility of the ink, etc. Application at 2.

As disclosed on page 22, line 17 through page 28, line 12 and illustrated in figure 6, a preferred way of determining the natural period of a recording head is by comparing various ink weights that result from different pulse widths. Additionally, at page 28, line 18 through page 30, line 4, a method of measuring the natural period based on the ink velocity is disclosed.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Whether claims 1, 2, 4, 6, 7, 9, 13, 14, 16, 17, 23-26, 31, 34, 35, 37-39, 43 and 44 are anticipated under 35 U.S.C. § 102(e) by Anderson et al. (USP 6,116,717);

B. Whether claim 3 is patentable under 35 U.S.C. § 103(a) over Anderson et al. in view of Milbrandt (USP 4,631,548);

C. Whether claim 5 is patentable over Anderson et al. in view of Jacobs et al. (USP 5,704,675);

D. Whether claims 8 and 30 are patentable over Anderson et al. in view of Nagoshi et al. (USP 6,224,182) and Jacobs et al.; and

E. Whether claims 10-12, 32 and 40-42 are patentable over Anderson et al. in view of Arthur et al. (USP 5,049,898).

VII. ARGUMENT

Appellant respectfully requests that the Board reverse the Examiner's rejection of claims 1-14, 16, 17, 23-26, 30-32, 34, 35 and 37-44.

Claims 1, 2, 4, 6, 7, 9, 13, 14, 16, 17, 23-26, 31, 34, 35, 37-39, 43 and 44 stand rejected under 35 U.S.C. § 102(e) as being allegedly anticipated by Anderson et al. (USP 6,116,717); claim 3 stands rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Anderson et al. in view of Milbrandt (USP 4,631,548); claim 5 stands rejected as being allegedly unpatentable over Anderson et al. in view of Jacobs et al. (USP 5,704,675); claims 8 and 30 are rejected as being allegedly unpatentable over Anderson et al. in view of Nagoshi et al. (USP 6,224,182); and Jacobs et al. and claims 10-12, 32 and 40-42 are rejected as being allegedly unpatentable over Anderson et al. in view of Arthur et al. (USP 5,049,898).

Appellant respectfully requests that the Board reverse each of these rejections at least because Appellant believes that each rejection is based on a misunderstanding of the Anderson reference.

Claims 1, 2, 4, 6, 7, 9, 13, 14, 16, 17, 23-26, 31, 34, 35, 37-39, 43 and 44 are not anticipated under 35 U.S.C. § 102(e) by Anderson et al. (USP 6,116,717)

Claim 1 is the only independent claim and recites in pertinent part:

> executing a plurality of ink droplet ejections from the nozzle orifice, ***while varying*** an ejecting time duration as ejecting conditions to measure either corresponding ejected amounts of ink droplets or corresponding ejected speeds as ejecting results;
>
> identifying a correlation between the ejecting conditions and the ejecting results based on the plurality of ink droplet ejections; and
>
> classifying the assembled recording head into a plurality of ranks, based on the identified correlation.

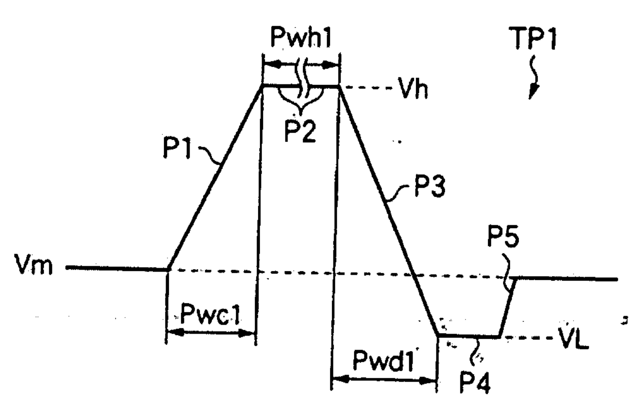
Claim 1 (emphasis added).

Anderson at least fails to disclose that a plurality of ink drop ejections are executed "***while varying an ejecting time duration***... to measure either corresponding ejected amounts of ink droplets or corresponding ejected speeds", as claimed. Anderson also fails to disclose the "ranks" recited in claim 1.

Anderson does not disclose the "while varying an ejection time duration..." limitation of claim 1

With reference to Fig. 4, the application discloses a preferred embodiment whereby multiple "evaluation pulses" TP1 are ejected with varied generation times Pwh1 to measure the ink amounts. Application at 22:12-23. The time period "Pwh1" corresponds to the first holding element P2, which is the portion of time between the excitation element P1 and the ejection element P3. The duration of P2 (Pwh1) is varied for each of a series of pulses TP1. The amount of ink ejected from these time-varied pulses is measured and the results are used to rank the recording head. Application at 23:15-26:22.

FIG.4



As explained in the application:

> And, in the step of measuring the ink amount, a plurality of generation times Pwh1 are established. That is, a plurality of types of evaluation pulses TP1, in which the time Pwh1 of generation of the first holding element P2 differs, are used, and measurements of the amount of ink are carried out several times.
>
> In the present embodiment, the amount of ink is measured three times, by using a first evaluation pulse in which the time Pwh1 of generation is set to a first reference time that becomes the reference, a second evaluation pulse in which the time Pwh1 of generation is set to a second reference time that is shorter than the first reference time, and a third evaluation pulse in which the time Pwh1 of generation is set to a third reference time that is longer than the first reference time.

Application at 22:12-23.

While Anderson may vary the time duration for heater resistance measurements, Anderson does not teach varying the time duration of the pulses during the measurement process for the ink drop mass or during the measurement process for ejection speed.

Anderson discloses that the heater resistance is first measured. (See, e.g., Col. 4, Lines 16-19, "... a <u>fixed voltage</u> can be applied while selectively enabling sections of the array <u>one section at a time</u> and measuring current when a drop <u>or drops are ejected</u> from each section". With respect to the heater resistance measurements, Anderson does disclose at Col. 4, Lines 7-10, that "[t]he nominal pulse widths ... typically vary from 0.5 microseconds to 2.5 microseconds". Since the latter portion of the above description allows for plural ink ejections, Anderson teaches that the plural measurements are executed while varying the ejecting time duration <u>only for</u> the case of the heater resistance measurement.

However, in the case where either the ejected amounts (mass) or the ejected speeds of the ink droplets are measured, as claimed, the above discussion is not applicable. For example, at

Col. 4, Lines 54-56, Anderson discloses, "[o]nce the resistance adjustments have been made, the electrical process variations are no longer variable in consistency of drop production". Since the "electrical process variations" include the pulse widths of the evaluation pulses, the mass measurement pulse durations are taught to be fixed.

The concept in Anderson can be summarized as follows. For each of the heaters and for any one or more of the characteristics including the heater resistance, drop mass, and drop velocity, an offset from a design value is identified under a certain ejecting condition, and then a drive signal is modified so as to compensate for the offset in order to optimize the operation of each heater. Although the plural form expression "pulse widths" is used in the step 168 or later in Fig. 3 of Anderson, the ejecting time duration (ejecting condition) is not varied. Rather, since the first measurement (heater resistance) is performed with respect to plural heaters, different pulse widths are set to compensate different offset values which are obtained by the first measurement. Actually, in the step 160 showing the ejection condition of the first measurement, the single form expression "pulse width" is used. In any event, for each of the nozzles or the heaters, Anderson's ejecting condition must be constant when the ejecting amounts or the ejection speeds are measured. Therefore, Appellant submits that Anderson fails to satisfy the claimed requirement in this regard.

That is, Anderson does not disclose "executing a plurality of ink droplet ejections from the nozzle orifice, while varying an ejecting time duration as ejecting conditions to measure either corresponding ejected amounts of ink droplets or corresponding ejected speeds as ejecting results", "identifying a correlation between the ejecting conditions and the ejecting results based on the plurality of ink droplet ejections" and "classifying the assembled recording head into a plurality of ranks, based on the identified correlation", as claimed. To the contrary, consistent

with the discussion above, Anderson discloses ejecting ink from a nozzle orifice at a fixed ejecting time duration, identifying an offset between the ejecting result and a designed value and modifying the ejecting time duration to compensate the identified offset to optimize the ink ejection.

While Anderson does disclose that "the fire pulse should be adjusted" (col. 6, lines 66-67), this adjustment is made after measuring ink drop mass on the basis of measured heater resistances. The adjustment is not made based on results from "executing a plurality of ink droplet ejections from the nozzle orifice while varying an ejecting time", as required by the claims on appeal.

In the Final Office Action the Examiner indicated that he disagrees with Appellant's position that Anderson et al. fails to teach or suggest "executing a plurality of ink droplet ejections from the nozzle orifice, while varying an ejecting time duration...". Specifically, the Examiner has cited col. 6, line 60 through col. 7, line 11 of Anderson et al. as allegedly disclosing this feature.

It is respectfully submitted that the Examiner has misinterpreted the Anderson disclosure. The cited passage discloses measurements taken of a series of pulses, followed by adjustment of the pulse width. Anderson does not vary an ejection time duration *while* executing a plurality of ink droplet ejections to measure one parameter as claimed.

The cited passage of Anderson merely discloses the "cartridge characterization" process that is entirely different than the claimed method of claim 1. That is, as explained in the paragraphs immediately preceding the cited passage of Anderson et al., the drive pulse width is adjusted to compensate for variations in previously delivered ink mass which results from variations in the resistances of each of the heaters within each of the driven pressure chambers.

In the example disclosed in Anderson, a nominal pulse width of 1.6 microseconds is determined. This pulse width includes a 0.3 microsecond pre-heat pulse during which no ink is output, and a 1.3 microsecond main pulse during which ink is output from each driven chamber of the print head. Further, a 0.9 microsecond off time separates the two pulses and a nominal value of 35.85 ohms is used for the heater resistance.

Based on the resistance measurements, a delta of 0.1 microseconds was added to the main drive pulse resulting in a main drive pulse of 1.4 microseconds for the respective section of the heater array. Similar steps were then performed for each of the sections of the heater array.

Then, in the passage cited by the Examiner, the nozzles are fired using the adjusted pulse widths and the ink drop mass is measured for each nozzle opening in the respective array sections. There is no teaching in this passage or anywhere else in Anderson that the pulse widths were changed ***during*** this ink drop mass measurement process. The only adjustment to pulse widths in relation to the ink drop mass measurement, is an adjustment after the measurements are made and an offset is calculated. E.g., Anderson Fig. 3, steps 168-172.

Thus, Anderson et al. discloses a method of characterizing print cartridges that is entirely different from the claimed method. While Anderson does disclose that "the fire pulse should be adjusted" (col. 6, lines 66-67), this adjustment is made after measuring ink drop mass <u>on the basis of measured heater resistances</u>. The adjustment is not made based on results from "executing a plurality of ink droplet ejections from the nozzle orifice <u>while varying an ejecting time</u>", as required by the claims.

Anderson's ejecting conditions during the ink drop mass measurements and during the ink speed measurements, are disclosed as being constant, not varied. The disclosure of Anderson that "the fire pulse should be adjusted" clearly means that such an adjustment is made after the

measurement, in order to determine each value in the offset table shown in Col. 7, which is used for actually correcting such a fire pulse which "should be" adjusted. If the ejecting condition (i.e., the fire pulse) was adjusted during each measurement as alleged by the Examiner, it would be impossible to obtain the specific values in the offset table.

Anderson does not disclose the "ranks" limitation of claim 1

Further, in accordance with the claimed invention, a correlation (or trend) between different ejecting conditions and corresponding ejecting results, e.g., as shown in Fig. 6, is obtained. The trend is subsequently used to classify, or rank, the recording heads.

Appellant respectfully submits that "ranking", as claimed, is not taught or suggested by the "optimizing" that is disclosed in Anderson. In the Office Action of November 16, 2004 (page 12), the Examiner contends that the Anderson "optimizing" is "equivalent" to the claimed "ranking". Appellants respectfully submit that the Examiner's "equivalency" position is a tacit admission that Anderson does not expressly disclose every element of the pending claims, and therefore the § 102 rejection must be reversed.

Appellants also submit that the Examiner's equivalency assertion is not supported by any evidence in this record. Anderson's "optimization" is directed to the establishment of a single offset value for each parameter, whereas "ranking" allows for the consideration of a plurality of states and parameters, as shown, for example, in Fig. 7 and the associated description in the present application.

In accordance with the present invention, the same control condition can be applied to different controlled objects if the objects are classified into the same rank. The ranking concept as claimed is much more economical than the Anderson concept of optimization because, in accordance with control based on optimization, a <u>unique</u> control condition must be provided with

respect to each of the controlled parameters. For this additional reason Appellant submits that Anderson discloses a different concept than the concept claimed, and the Anderson concept does not teach or suggest the expressly claimed "ranks".

Since Anderson fails to disclose at least the above two aspects of the only independent claim, the anticipation rejection is improper. In addition, since the above described deficiencies of Anderson are not cured by any of the applied art, Appellant submits that all of the pending rejections are unfounded.

Claims 2, 4, 6, 7, 9, 13, 14, 16, 17, 23-26, 31, 34, 35, 37-39, 43 and 44 are not anticipated by Anderson

Claims 2, 4, 6, 7, 9, 13, 14, 16, 17, 23-26, 31, 34, 35, 37-39, 43 and 44 depend from claim 1 and are patentable at least for the reasons set forth above. In addition, these claims more particularly define aspects of the invention that are also not disclosed by Anderson.

For example, Anderson does not disclose "measuring the ejected amounts as the ejecting results while varying a time period between a termination end of the excitation element and an initial end of the ejection element" (claim 2); "measuring the ejected speeds while as the ejecting results varying a time period between a termination end of the excitation element and an initial end of the ejection element" (claim 4).

Claims 6, 7, 38, and 39 require a duration based on the "natural period." e.g., claim 6 "duration of the excitation element is equal to a natural period... or less"; claim 7 "duration of the excitation element is equal to one half of a natural period ... or less".

The Examiner alleges that these features are found in Anderson in the table in column 7. Office Action of November 16, 2004, at 3. Appellant respectfully disagrees with the Examiner

at least because the table in column 7 has no teaching of the natural period, and what is being measured in Anderson is not the natural period of the ink pressure fluctuation.

Anderson discloses measuring the mass of ejected ink (col. 4, line 66 through col. 5, line 14) and measuring the ink velocity of ejected droplets (col. 5., lines 23-34). However, these two measurements alone do not comprise a measurement of the natural period, as claimed. Instead, these two measurements, ink mass and ink velocity, are used in Anderson to build second and third offset tables, respectively. A first offset table is built based on resistance measurements of the array of heater elements. (See col. 4, line 30 through col. 5, line 45 and Figs. 3 and 4). The three offset tables are then used together to control the drive signal to the print head.

To the contrary, in the claimed invention either measured ink volume or measured ink velocity can be used to determine the natural period of the recording head. However, either measurement alone is insufficient to determine the natural period. As disclosed on page 22, line 17 through page 28, line 12 and illustrated in figure 6, ***the natural period*** of a recording head is measured by comparing various ink weights that ***result from different pulse widths***. Additionally, at page 28, line 18 through page 30, line 4, a method of measuring the natural period based on the ink velocity is disclosed.

Anderson et al. discloses a method in which various offset tables are determined based on resistance values of the heater elements, ink volume and ink velocity, respectively. The offset tables are used to control the drive signal to the recording head. Nowhere in Anderson is it disclosed to measure the natural period of the recording head. The Anderson never even mentions the natural period. For this reason as well, claims 6, 7, 38, and 39 are further patentable over Anderson.

Claims 9, 13, 14, 17, 31, 35, 43, and 44 further add requirements pertaining to the classified ranks. Since Anderson fails to disclose classified ranks, these claims are further patentable.

Claim 3 is patentable under 35 U.S.C. § 103(a) over Anderson et al. in view of Milbrandt (USP 4,631,548)

Claim 3 adds to claim 2, requirements based in part on a natural period. For the reasons set forth above regarding claim 1 and claim 6, claim 3 is patentable over Anderson in view of Milbrandt since Milbrandt fails to cure the deficiency of Anderson regarding natural periods and the deficiencies discussed regarding claim 1.

Claim 5 is patentable over Anderson et al. in view of Jacobs et al. (USP 5,704,675)

Claim 5 depends from claim 1 and is patentable based on the above reasons for claim 1 as well as all intervening claims. In addition, this claim adds to claim 4, requirements based in part on a natural period. For the reasons set forth above regarding claim 6, claim 5 is patentable over Anderson in view of Jacobs since Jacobs fails to cure the deficiency of Anderson regarding natural periods.

Claims 8 and 30 are patentable over Anderson et al. in view of Nagoshi et al. (USP 6,224,182) and Jacobs et al.

Claims 8 and 30 depend from claim 1 and are patentable based on the above reasons for claim 1 and all intervening claims. In addition, these claims recite four specific ranks based on the natural period. None of the applied art even mentions the claimed ranks or natural periods, thus for the reasons set forth above regarding ranks and natural periods, claims 8 and 30 are also patentable over the applied combination.

Claims 10-12, 32 and 40-42 are patentable over Anderson et al. in view of Arthur et al. (USP 5,049,898)

Claims 10-12, 32, and 40-42 depend from claim 1 and are patentable based on the above reasons for claim 1 and all intervening claims. These claims also add requirements pertaining to the classified ranks. Since Anderson fails to disclose classified ranks and Arthur fails to make up for this deficiency, these claims are further patentable.

Conclusion

For the reasons set forth above, Appellants respectfully request that the Board reverse the Examiner's rejections of claims 1-14, 16, 17, 23-26, 30-32, 34, 35 and 37-44.

Unless a check is submitted herewith for the fee required under 37 C.F.R. § 41.37(a) and 1.17(c), please charge said fee to Deposit Account No. 19-4880.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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WASHINGTON OFFICE
23373
CUSTOMER NUMBER

Date: June 14, 2005

CLAIMS APPENDIX

CLAIMS 1-14, 16, 17, 23-26, 30-32, 34, 35 and 37-44 ON APPEAL:

1. A method of manufacturing an ink jet recording head which includes a plurality of nozzle orifices forming at least one nozzle row, pressure chambers each communicated with the associated nozzle orifice, pressure generating elements each generating pressure fluctuation in ink provided in the associated pressure chamber to eject an ink droplet from the associated nozzle orifice, the method comprising the steps of:

assembling the ink jet recording head;

executing a plurality of ink droplet ejections from the nozzle orifice, while varying an ejecting time duration as ejecting conditions to measure either corresponding ejected amounts of ink droplets or corresponding ejected speeds as ejecting results;

identifying a correlation between the ejecting conditions and the ejecting results based on the plurality of ink droplet ejections; and

classifying the assembled recording head into a plurality of ranks, based on the identified correlation.

2. The manufacturing method as set forth in claim 1, wherein the step of executing the ink droplet ejections includes the steps of:

supplying an evaluation signal including at least an excitation element which excites the ink pressure fluctuation, and an ejection element which follows the excitation element to eject the ink droplet from the nozzle orifice; and

measuring the ejected amounts as the ejecting results while varying a time period between a termination end of the excitation element and an initial end of the ejection element as the ejecting conditions.

3. The manufacturing method as set forth in claim 2, wherein the time period includes at least:

a first time period which is determined such that the ejected ink amount becomes minimum when a natural period is as per a designed criterion;

a second time period which is shorter than the first time period; and

a third time period which is longer than the first time period.

4. The manufacturing method as set forth in claim 1, wherein the step of executing the ink droplet ejections includes the steps of:

supplying an evaluation signal including at least an excitation element which excites the ink pressure fluctuation, and an ejection element which follows the excitation element to eject the ink droplet from the nozzle orifice; and

measuring the ejected speeds while as the ejecting results varying a time period between a termination end of the excitation element and an initial end of the ejection element.

5. The manufacturing method as set forth in claim 4, wherein the time period includes at least:

a first time period which is determined such that the ejection speed becomes minimum when a natural period is as per a designed criterion;

a second time period which is shorter than the first time period; and

a third time period which is longer than the first time period.

6. The manufacturing method as set forth in claim 2, wherein duration of the excitation element is equal to a natural period as per a designed criterion or less.

7. The manufacturing method as set forth in claim 6, wherein the duration of the excitation element is equal to one half of a natural period as per the designed criterion or less.

8. The manufacturing method as set forth in claim 1, wherein the plurality of ranks includes at least a first rank which indicates an actual natural period is as per a designed criterion, a second rank which indicates the actual natural period is shorter than the designed criterion, a third rank which indicates the actual natural period is longer than the designed criterion, and a fourth rank which indicates an erroneous condition.

9. The manufacturing method as set forth in claim 1, further comprising the step of indicating the classified rank on the assembled recording head.

10. The manufacturing method as set forth in claim 9, wherein the classified rank is indicated by a symbol.

11. The manufacturing method as set forth in claim 9, wherein the rank is determined with regard to the respective nozzle rows; and

wherein the rank is indicated by a symbol which indicates a combination of the classified ranks of the respective nozzle rows.

12. The manufacturing method as set forth in claim 9, wherein the classified rank is indicated by coded information which is readable by an optical reader.

13. The manufacturing method as set forth in claim 1, further comprising the steps of:

providing a memory; and

storing electrically information indicating the classified rank in the memory.

14. A method of driving the ink jet recording head comprising the steps of:

providing a rank indicator which indicates one of the ranks classified in the method as set forth in claim 1;

providing a drive signal including at least one wave element having a control factor which is defined in accordance with the rank indicated by the rank indicator; and

supplying the drive signal to the pressure generating element.

16. The driving method as set forth in claim 14, wherein the drive signal is provided with a characteristics changing element which changes ejection characteristics of the ink droplet; and

wherein a control factor of the characteristics changing element is defined in the drive signal provision step.

17. An ink jet recording apparatus, comprising:

an ink jet recording head, comprising a rank indicator which indicates one of the ranks classified by the method as set forth in claim 1; and

a waveform controller, which provides a drive signal including at least one wave element having a control factor which is defined in accordance with the classified rank.

23. The recording apparatus as set forth in claim 17, wherein the drive signal is provided with a characteristics changing element which changes ejection characteristics of an ink droplet; and

wherein the waveform controller defines a control factor of the characteristics changing element.

24. The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a drive pulse including:

an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected; and

an ejection element, which follows the expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice; and

wherein duration of at least one of the first expansion element and the first ejection element is defined by the waveform controller.

25. The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a drive pulse including:

an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected; and

an ejection element, which follows the expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice; and

wherein a potential difference between an initial end and a termination end of at least one of the expansion element and the ejection element is defined by the waveform controller.

26. The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a drive pulse including:

an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected;

a holding element, which follows the expansion element to hold the expanded state of the pressure chamber; and

an ejection element, which follows the expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice; and

wherein the waveform controller defines duration of the holding element.

30. The driving method as set forth in claim 14, wherein the plurality of ranks includes at least a first rank which indicates an actual natural period is as per a designed criterion, a second rank which indicates the actual natural period is shorter than the designed criterion, a third rank which indicates the actual natural period is longer than the designed criterion, and a fourth rank which indicates an erroneous condition.

31. The recording apparatus as set forth in claim 17, further comprising: a memory, which electrically stores information indicating the classified rank, the memory electrically connected to the waveform controller.

32. The recording apparatus as set forth in claim 17, further comprising:

a rank indicator, provided with the recording head to indicate the classified rank thereof so as to be optically readable; and

an optical reader, which optically reads the classified rank indicated by the rank indicator,

wherein the waveform controller acquires the classified rank read by the optical reader.

34. The recording apparatus as set forth in claim 17, wherein the pressure generating element is a heating element.

35. An ink jet recording head, comprising a rank indicator, which indicates one of the ranks classified by the method as set forth in claim 1.

37. The recording apparatus as set forth in claim 35, wherein the pressure generating element is a heating element.

38. The manufacturing method as set forth in claim 4, wherein duration of the excitation element is equal to a natural period as per the designed criterion or less.

39. The manufacturing method as set forth in claim 38, wherein the duration of the excitation element is equal to one half of a natural period as per the designed criterion or less.

40. The ink jet recording head as set forth in claim 35, wherein the classified rank is indicated by a symbol.

41. The ink jet recording head as set forth in claim 35, further comprising a plurality of nozzle rows;

wherein the rank is determined with regard to the nozzle rows; and

wherein the rank is indicated by a symbol which indicates a combination of the classified ranks of the nozzle rows.

42. The ink jet recording head as set forth in claim 35, wherein the classified rank is indicated by coded information which is readable by an optical reader.

43. The ink jet recording head as set forth in claim 35, further comprising a memory which electrically stores information indicating the classified rank.

44. The manufacturing method as set forth in claim 1, wherein at least one of the ranks is associated with a plurality of correlations.

EVIDENCE APPENDIX:

There has been no evidence submitted pursuant to 37 C.F.R. §§ 1.130, 1.131, or 1.132 or any other similar evidence.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings.